METHOD AND APPARATUS FOR PARTITIONING SYSTEM MANAGEMENT INFORMATION FOR A SERVER FARM AMONG A PLURALITY OF LEASEHOLDS

RELATED APPLICATION

The present invention is related to commonly assigned and co-pending U.S. Patent Application Serial No. 09731613 (Attorney Docket No. AUS920000416US1) entitled "METHOD AND APPARATUS FOR TIME DECAY MONITORING OF APPLICATION, NETWORK AND SYSTEM BEHAVIOR," filed on even date herewith, and which is hereby incorporated by reference. FN 3/30/04

BACKGROUND OF THE INVENTION

1. Technical Field:

The present invention is in the general area of computing systems and information technology and is directed more specifically to the management of a large number of such systems where the systems are divided among a number of different customers. The present invention is directed to a method and apparatus for partitioning system management information for such a server farm among a plurality of -customers.

2. Description of Related Art:

Thin servers or server appliances have been developed to provide specialized servers that are typically cheaper and easier to install and use than traditional server computer systems. The terms *thin*

server and *server appliance* are essentially synonymous and are used interchangeably throughout the balance of this document. A thin server is a network-based computer specialized for some function such as print serving, ISDN routing, web serving or network attached storage (NAS). Web server software is often built in allowing management and control via a Web browser residing on any client platform in the network although that is not a necessary feature.

Farms or clusters of thin servers are being used to provide web-based application services as a single system from an administrative and management perspective while maintaining multiple execution images. For a variety of reasons including bandwidth access, cost reduction and flexibility, many web-based applications are being hosted on thin server farms, or clusters, which are owned and/or operated by other groups, and in turn, these groups may lease portions of the facility to a number of different customers. When a server farm is split among multiple end customers, each of whom has contractually defined rights to service from the hardware and software in the farm, the farm is described as being partitioned into *leases* or *leaseholds*.

In known farms, all management function is performed by the owner or operator of the farm on behalf of all of its customers. A standardized report is then generated and provided to each of the customers. The standardized report provides information that may not be easily used by the customers since the standardized report is not specific to each customer. The report is also static and does not allow for direct and interactive management of the resources within the farm as a part of the customers'

overall information technology infrastructures using the customers' previously established management tools and methodologies. Accordingly, it would be beneficial to have a method and apparatus for partitioning system management information for a server farm among a plurality of leaseholds in such a manner as to facilitate the use of the individual customers' pre-existing system management tools.

SUMMARY OF THE INVENTION

The present invention provides a method and apparatus for partitioning system management information among a plurality of leaseholds. With the method and apparatus of the present invention, a thin server farm is operated as a shared or leaseable facility. As such, the customers using the shared facility execute their server applications on the servers that they lease and provide system management agents that run on a thin server manager, which may be implemented as part of a management server appliance for the thin server farm, for example. The agents gather management information and perform management functions on the portion of the shared facility that they are currently using.

With the present invention, the thin server manager aggregates all of the information about the applications, the network and the systems in the network. The thin server manager is also given a set of information, which may be in the form of extended markup language (XML) documents, that describes the leases that are in force and the service-level agreements of contractually defined obligations associated with each of the leases. The thin server manager has, as part of its management information base, the current assignments of resources to each leaseholder, the status of each lease, and how the resources are being used, e.g., what applications are being run under the lease, on how many servers the applications are being run, how much network bandwidth is being used, the level of success of running the

applications, and the like. Based on this information, the thin server manager creates for each lease a computer-processable document in a form, such as XML, that it forwards to an adapter for each of the leaseholder agents.

The adapters and the leaseholder agents may all run on a management server appliance or metaserver system or be on different systems. Each adapter acts as a translation layer, converting the document to a format which the leaseholder's agent can handle. The document contains only the information about the leased resources rather than a full picture of the facility.

If the leaseholder's system management software issues a command to some entity within the leased portion of the server farm, the command is translated by the adapter to a document parsable by the thin server manager. The thin server manager determines if the command is an appropriate command, makes any required translations or restrictions, and then forwards it to one or more agents within the leasehold.

The present invention offers, among others, three major advantages in the operation of server farms, especially ones using thin servers or server appliances. First, the present invention provides a mechanism for a single server appliance to manage multiple sets of appliances where each set is being used by a different customer of the server farm or for a different purpose. Second, the present invention allows each customer of the thin server farm to use the customer's own system management infrastructure to manage its portion of the thin server farm as an extension of the information technology systems that the customer owns or already has.

Third, the invention eliminates the cumbersome and often usable reports that are typically generated by a service provider or server farm operator for its customers. Other features and advantages of the present invention will be described in, or will become apparent to those of ordinary skill in the art in view of, the following detailed description of the preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

Figure 1 is an exemplary diagram illustrating a distributed data processing system according to the present invention;

Figure 2 is an exemplary block diagram illustrating one embodiment of the thin server manager according to the present invention; and

Figure 3 is a flowchart outlining an exemplary operation of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 is an exemplary block diagram illustrating a distributed data processing system according to the present invention. As shown in **Figure 1**, the distributed data processing system includes a metaserver **110**, a switch **120**, one or more thin servers **130**, network attached storage (NAS) **140**, network dispatcher **150**, external network **160**, and one or more client devices **170-190**. The metaserver **110**, switch **120**, thin servers **130**, NAS **140** and network dispatcher **150** are part of a local area network **100** coupled to the external network **160**. In Figure 1, data flow is denoted by lines having arrow heads while actual physical connections are denoted by solid lines. In actuality, all data packets are routed through the switch **120**.

The distributed data processing system shown in **Figure 1** is illustrative only. The particular architecture and elements shown in **Figure 1** are not intended to place any limitations on the architecture and elements used with the present invention. Rather, the distributed data processing system may have many other architectures and may include other elements in addition to, or in replacement of, the elements shown in **Figure 1** without departing from the spirit and scope of the present invention.

In the data processing system of **Figure 1**, the thin servers **130** provide specialized applications to client devices **170-190** via the external network **160** and the network dispatcher **150**. The thin servers **130** may provide

any number of different applications, including print applications, database applications, web-serving applications, and the like.

The external network **160** may be any type of data network known to those of ordinary skill in the art. The external network **160** may be, for example, the Internet, an intranet, a wide area network (WAN), local area network (LAN), wireless data network, satellite data network, or the like. The external network **160** may also be any combination of the above.

The client devices **170-190** may be any type of computing device capable of accessing the thin servers **130** via the external network **160** and the network dispatcher **150**. The client devices **170-190** may be, for example, a personal computer, laptop computer, personal digital assistant (PDA), data network capable wireless communication device, and the like. The client devices **170-190** may access applications provided by the thin servers **130** using, for example, a web browser application or the like.

The network dispatcher **150** performs workload balancing with regard to the thin servers **130** with the goal being to avoid looking at every packet, especially every packet sent back by the thin servers **130**. The network dispatcher **150** dispatches jobs or transaction requests to the thin servers **130** and the NAS **140**. The network dispatcher **150** essentially provides a mechanism through which job or transaction requests may be sent to applications running on the thin servers **130** The responses to these job or transaction requests are supplied directly by the thin servers **130** through the

switch **120** to the external network **160** and hence to the clients **170 - 190**.

The NAS **140** is a specialized file server that connects to the network. The NAS **140** uses traditional local area network (LAN) protocols, such as Ethernet and TCP/IP and processes only file I/O requests such as Network File System (NFS)(UNIX) and Server Message Block (SMB)(DOS/Windows).

The switch **120** is an electronic device that directs the flow of data from one side of the switch to the other. The switch **120** may be any type of data switching device known to those of ordinary skill in the art. For example, the switch **120** may be an Ethernet switch, a hub, a router, or the like. The switch **120** serves to route data and message traffic to appropriate devices **110**, **130**, **140** and **150**.

The metaserver **110** performs the function of managing the devices in the local area network, e.g., the switch **120**, the thin servers **130**, the NAS **140** and the network dispatcher **150**. In managing these devices, what is meant is that the metaserver **110** performs management functions including collecting data to maintain statistics of historical interest and to monitor the current state of the devices. The metaserver **110** may be a server, as is generally known in the art, or may be a specialized thin server that is used to perform management functions. In the depicted example, the metaserver **110** is a specialized thin server.

The present invention provides a mechanism by which system management information is partitioned and provided to customers of a server farm. With the present

invention, a thin server manager is utilized to aggregate system management information for a plurality of customers of a server farm. The aggregated system management information is then partitioned into sets, one for each leasehold, and provided to adapters of the leaseholder agents in a form that is susceptible to automated computer processing. An example of such a form is a valid XML document with a well-defined document type definition.

The adapters translate the received set into a form useable by the leaseholder agents, which then interact with the customer's management system. Thus, the customer's management system software, which is typically purchased from a vendor and may represent a substantial investment, does not need to be changed.

The management server appliance, or metaserver, shown in **Figure 1** operates based on instructions stored in local memory or storage. These instructions may include, for example, computer program instructions for implementing the thin server manager of the present invention. Alternatively, the thin server manager, as will be described hereafter, may be implemented as a hardware component of the metaserver, as software instructions, or a combination of hardware and software.

Figure 2 is an exemplary block diagram illustrating a thin server manager according to the present invention. As shown in **Figure 2**, the metaserver (or other management server) **210** includes a plurality of leasehold agents **222, 224, 226**, a thin server manager **230**, and a plurality of adapters **223, 225, 227** coupled to respective agents **222, 224, 226** and the thin server manager **230**.

The thin server manager **230** aggregates system

management information from the application subsystems **242**, **244** and **246**, operating systems **248**, **250** and **252**, network interfaces **254**, **256** and **258**, and hardware **260**, **262** and **264**, of the individual servers of the thin server farm **280** for each of a plurality of leaseholds.

The aggregated system management information may include, for example, the assignment of resources to each leaseholder, the status of each lease, and how the resources are being used. For example, the aggregated system management information may include an identification of the applications run under the lease, the number of thin servers on which the applications for each lease were run, the amount of network bandwidth used by each lease, the level of success of running the applications, and the like. The aggregated system management information may include other management information in addition to, or in replacement of, the management information described above.

In a preferred embodiment, system management information may be obtained from the thin server farm **280** by sending requests from thin server manager **230** to the systems being managed and receiving the system management information in response to the systems having received the requests. The request and response messages passed between the thin server manager **230** and the managed systems are, in a preferred embodiment, in an extensible Markup Language (XML) format, although other formats may be used without departing from the spirit and scope of the present invention.

The thin server manager **230** aggregates this system management information and then partitions the system management information into system management information

sets for each of the plurality of leaseholds. In partitioning the system management information, the thin server manager **230** uses the lease information, to identify each of the leaseholds and the corresponding system management information. The lease information may be provided to the thin server manager **230** in a parsable format, such as an extensible markup language (XML) document, or the like.

For example, each leasehold may be represented in the thin server manager **230** by a set of data structures that point to the resources owned by that leasehold, the resources (such as NAS, for example) sub-allocated to the leasehold, and information about each of these owned and sub-allocated resources. Based on the information stored in these data structures, correlation of the leasehold with management information from the various managed systems, i.e. resources, may be performed.

The partitioned system management information is then used to generate a document for each of the leaseholds. The document is preferably in a well-defined format that is readily processed by computer programs, such as an XML document, or the like. The documents may be generated at predetermined times, such as daily, weekly, monthly or the like, may be generated based on the occurrence of certain events or the completion of certain activities, or may be generated when instructed to do so by an administrator, or the like. Documents directed to different agents for different leaseholds may be generated at different times, depending on the particular needs of the customer.

The agents **222, 224, 226** may include, integrated therein, adapters **223, 225,** and **227** for the customer

management systems. Alternatively, the adapters **223**, **225** and **227** may be separate devices or virtual entities present in the metaserver **210**. There is at least one adapter **223**, **225** and **227** for each of the leaseholds managed by the thin server manager **230**.

The adapters **223**, **225** and **227** receive the documents generated by the thin server manager **230** and act as a translation layer for the agents of the customer management systems **222**, **224** and **226**. The adapters **223**, **225** and **227** parse the received documents and convert them to the form handled by the corresponding agents **222**, **224**, **226**. For example, the adapter may receive the document in an XML format and convert the document to an application program interface (API) calls, remote program calls (RPCs), or the like.

The converted document is then used by the customer's management system **290**, **292**, **294** to perform system management functions. These system management functions may include sending commands to applications running on the thin server farm. If commands are received from the customer's management system **290**, **292** or **294**, the commands are received by the agents **222**, **224**, **226** and converted into a form usable by the thin server manager **230**, preferably a document in a format such as XML. The thin server manager **230** then determines if the command is an appropriate command, and if so, makes any necessary translations or restrictions and forwards the command to the application. Commands are considered appropriate if they do not interfere with other leases or affect the overall operation of the server farm.

Figure 3 is a flowchart outlining an exemplary

operation of the present invention. As shown in **Figure 3**, the operation starts with receiving system management information from the thin server farm (step **310**). The system management information is partitioned (step **320**) and a document is generated for each of the leaseholds (step **330**). The documents are then transmitted to a customer's management system adapter (step **340**). The adapter converts the document into a form useable by the customer's management system (step **350**) and transmits the converted form of the document to the agent of the customer (step **360**). The agent then operates normally sending the information to be processed by the customer's management system (step **370**). The operation then returns to step **310** to wait for the next set of information from the server farm.

Thus, the present invention provides a mechanism by which system management information from a thin server farm may be partitioned for use by a plurality of individual customer leaseholders. Each customer may use its own management system to receive the partitioned information and perform necessary management functions. Thus, there is no need to incorporate additional functionality into the customer's management system to accommodate managing applications and systems within a server farm at a service provider's site.

While the present invention has been described in terms of managing applications and systems in a thin server farm, the present invention is equally applicable to management of any "farm" of network appliances and devices. For example, the present invention may be utilized with a farm of regular servers, application servers, or the like. The use of a farm of thin servers

in the description of the preferred embodiments is for illustrative purposes only and is not meant to place any limitations on the present invention.

It is important to note that while the present invention has been described in the context of a fully functioning data processing system, those of ordinary skill in the art will appreciate that the processes of the present invention are capable of being distributed in the form of a computer readable medium of instructions and a variety of forms and that the present invention applies equally regardless of the particular type of signal-bearing media actually used to carry out the distribution. Examples of computer readable media include recordable-type media such a floppy disc, a hard disk drive, a RAM, and CD-ROMs and transmission-type media such as digital and analog communications links.

The description of the present invention has been presented for purposes of illustration and description, but is not intended to be exhaustive or limited to the invention in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. The embodiment was chosen and described in order to best explain the principles of the invention, the practical application, and to enable others of ordinary skill in the art to understand the invention for various embodiments with various modifications as are suited to the particular use contemplated.